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Abstract

Optimization of the Process Parameters Controlling the Degree of Amorphization during Mechanical Activation of Clay Using the Taguchi Method †

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Abstract: Mechanical activation in a planetary ball mill (BM) is an environmentally friendly process able to enhance the chemical and pozzolanic activity of natural clays. Those materials can be used as supplementary cementitious materials (SCMs) to partially replace Portland cement in concrete. The process parameters of the BM are directly related to the degree of amorphization and thus to the enhancement of the chemical activity. Design of experiments (DOE) is a well-known statistical tool, which can assist in selecting optimized conditions and in obtaining systematic data. However, full factorial design requires a large number of experiment. Taguchi method is based on the use of an Orthogonal Array (OA) to evaluate optimization of the selected factors but with less required experiments. In this study, three factors, each on 2 levels, were selected: ball to powder ratio (B/P) with level 3 and 25, time of grinding with level 5 and 20, and water to powder ratio (W/P) with level 0 and 1. The degree of amorphization (DOA) was selected as the main response for the Taguchi method. DOA was calculated as the ratio between the integral intensities of the main peak of the kaolinite [001] before and after grinding. For dry grinding, the predicted optimized value of DOA complied with the experimental results. Maximized DOA value was achieved for B/P equal to 25 and the grinding duration of 20. This method can be a valuable tool to predict the amorphization degree of minerals present in the natural clay, leading to the optimization of the mechanical activation process.

Keywords: mechanical activation; degree of amorphization; Taguchi method; clay-based binder; sustainable building materials; ball mill